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EDITORIAL NOTES

IT DOES HAPPEN

THE war becomes more intense. That was to be expected. A few days ago we thought we would enjoy an August trip to the coast. We felt honoured on the journey by a Nazi escort. He did no damage (we were travelling by train), nor did he affect morale. And so to the coast of jolly England. We thought we were *au fait* with the position of most gas undertakings in this country, but in this particular instance even journalistic buoyancy was somewhat calmed down on entrance to the town.

Quietude reigned; merely quietude. We asked the way to the gas-works, for the scene—once well known—was unfamiliar. We enquired of a postman; he said simply—you take first left round the "pub." that was. It happened to be, or to have been, a temperance establishment. That is a minor point in our little story. So we turned round the "pub. that was" and wended our way to our goal—the gas-works. And we came to the conclusion that the slick pen is not mightier than the sword, but that a steady pen might prove helpful. We arrived at the works.

The engineer there acted as a friend; for no sooner were we on the works—actually we were poised as ballet dancers on the crown of a gasholder—than he said you *must* "take cover." In issuing this command he had forgotten not one of his workmen. The home service demonstrator, a young and courageous girl, handed us all a sausage and gave us a pleasant smile. We retired behind sandbags, just before 24 Nazi planes, at that moment at 5,000 ft. or thereabouts, decided to dive. Dive they did! They dropped a few bombs indiscriminately and, with bombast, circled and went inland. Naturally we were rather disgusted with an exhibition of efficient formation flying on the part of doubtless young pilots, without military objective. A life here and there; a building here and there. But, from the point of winning the war—it seemed meaningless.

We have mentioned our approach to the gas-works. It was chastening; at the same time it was wonderfully heartening. Signs such as "Business as Usual—we hope," "Bring your joints here to be cooked; we have the fuel," met the eye. Altogether not merely a sense of camaraderie, but a complete expression of hope. The British temperament is uncannily enduring. The Nazis cannot understand it, but they will eventually feel its effects.

We seem, however, to be getting somewhat away from the point, our visit to the gas-works. The engineer at this particular works is responsible for gas supply, and he is also responsible for water supply. At the time of our vivid visit there was no gas in his area of supply; and a "no-gas" idea in these modern times is unwelcome—to say the very least. It was only a few days before our visit to this town "somewhere in England" (we think that readers will have a notion where it is) that the gas-works engaged the attention of the enemy. We happen to know, from first eye, what resulted from this attention. Bombs of considerable calibre—"plonk" on the works. A spot of flame from two gasholders—and we would emphasize flame, *not* explosion—strange, almost incredible effects of "blast," and then a return of the Nazis to machine-gun those who were extinguishing the flames. This is a pretty story. Also, it is true.

We were impressed with the safety precautions taken over two years at those works. Little that could have been done had been left undone. These precautions have saved money, and they have saved lives. Yet we wonder whether reasonable precautions such as these we are talking about have been taken by gas-works throughout the country. As we write this the warning siren sounds again.

When we were on those works a car drew in. It was chauffeur-driven, and a posse of fitters stepped out to reinforce those normally employed on the works. One said that the engineer from a neighbouring undertaking who had freely lent his aid was a "gentleman." But, said the engineer of the works which we visited, I always knew that. We all laughed. Co-operation became more evident. It was evinced in so many ways. It was evinced by the Gas Industry as a whole. Keenness to help was not the prerogative of gas engineers in the surrounding districts. The manufacturers of plant were on the spot. That they were a little more optimistic about immediate supply of gas to the town than we were matters nothing. Everybody helping; that was the point.

Slogans may or may not have value. We will, however, take a bow at a venture and coin one: "Gas-works are manned by workers with 'guts'—not forgetting the engineer." Is every gas-works in this country satisfied with the precautions it has taken against this type of bombing performance? Is every gas-works certain that it has sufficient spare parts available against emergency? We think we know the answer to this composite question, and we merely say: Take heed. In saying this we finish on the one dominant note of admiration for the co-operation within our Industry.

OUT OF THE LIMELIGHT

NOT very long ago we were speaking of the wartime activities of the British Commercial Gas Association. It was in our issue of July 24. We explained that at a meeting of the Emergency Executive Committee held just prior to that date a decision was reached that it would not be in the national interest to proceed with national advertising in the Press, and that no contracts for space would be placed "until further notice." Perhaps from time to time, we added, something might be done to inform the public of steps of importance which the Industry might take, but that it would be advertising neither in the sense of selling nor of that elusive element termed prestige. At a further meeting of the Executive Committee held recently the resolution was re-ratified. We are not at all certain that the majority notion will not result in an attitude of *laissez-faire*. Local undertakings do look to the central organization for guidance, help, and, more important, inspiration. To our mind, on its advertising policy, the B.C.G.A. has little with which to congratulate itself. Nor are we thinking of selling or prestige; we are thinking of giving the public, through the Press—and there is no better medium—useful and helpful information telling the millions of gas consumers throughout this land of ours what to do in circumstances dictated by air frightfulness and giving them some idea of what efforts—they are great efforts—the Industry is making to restore gas service in time of calamity and to make good recurrent ravages.

For the town in question—it is no secret—referred to in our preceding little note is Ramsgate. Within a matter of days—it may be hours—other gas undertakings may be experiencing a similar *temporary* disturbance. We italicize "temporary" because of the work, co-operative work, which is being put in to restore gas comfort to the inhabitants of that particular town. The dwellers there, as we have endeavoured to indicate, are brave and enduring beyond question. There is not a grumble in that town, only a sense of ultimate victory; and in this endurance women are playing their part gloriously. Meanwhile B.C.G.A. national advertising sits precariously

upon a fence which within seconds may find its flimsy structure shattered. We cannot understand this weak interpretation of advertising, and by Gas Industry advertising in the present somewhat strenuous times we mean practical announcements of value. We believe strongly that the Gas Industry in the past, since the last War, has helped its consumers far more than in merely supplying them with so many therms, each of 100,000 B.Th.U., in convenient energy.

It will now be gathered, we hope, that the Executive Committee's acquiescence in a policy of stultification is, in our opinion, misinterpretation of the public mind. Of course the public do not like gas bills. We have yet to find an individual who was especially enamoured by an electricity or any other form of bill. We have found, on the other hand, acceptance (say, 99% acceptance) of the responsibility for payment—payment with, maybe, admonition to a maid, a child, or (more daring) a wife, but payment with a smile if the services rendered have been regarded as commensurate with the monetary amount claimed. We think that Mrs. R or Mr. S, if in gas advertising they found good cheer and helpful advice, would not grudge a small expenditure, even by a public utility undertaking, in what might and probably would prove a lively benefit.

Having got that off our chest, let us consider for a moment the non-limelight work of the B.C.G.A., for we know full well that the organization is functioning to the utmost, within its strength, not at the moment primarily for the extended sale of gas but for the welfare of the Gas Industry's consumers. The staff is reduced, inevitably; peacetime 73, to-day 27. A year ago the staff officers numbered 17; to-day there are eight only. Every one, staff officers and staff, is working to capacity. Collaboration with the Ministry of Food, the Ministry of Information, the Ministry of Education, daily becomes closer. We have before us as we write details of some of the work accomplished. Government departments are looking to national organizations for advice; they do not look in vain to the organizations of the Gas Industry.

CRUDE TAR PRICES

IN our issue of August 14 we discussed the difficulty which has arisen in the case of contracts based upon "GAS JOURNAL" prices since the absence of any market price for pitch has prevented the weekly assessment of such crude tar price. A number of correspondents, both producers and buyers of crude tar, have been good enough to write expressing approval of the suggestion which we put out on behalf of our Market Correspondent, and none has so far either disapproved or made any alternative suggestion for overcoming the difficulty.

We are grateful for the assistance which such replies have given us, and in view of the apparent consensus of opinion our Market Correspondent agrees that, when there is again a market for pitch, he will endeavour to give a composite price to cover the period which has intervened, and also to give what we consider would be a fair price for tar, based upon that figure, for each month of the period during which no weekly price for crude tar has been given in the "JOURNAL."

With this assurance, we trust that those who have not already done so may now be able to agree among themselves upon an interim price to be paid on account, subject to adjustment later when we are able to give these restrospective prices. We must, however, emphasize that the stabilization of a market for pitch is beyond our control, and we can therefore promise no definite date for a resumption of prices, and we must ask interested parties to exercise forbearance in a matter which we realize has, through no fault of ours, caused a great deal of inconvenience.

"Gas Journal" Directory

In order that readers may be able to keep the particulars contained in the "JOURNAL" Directory up to date, we summarize below changes of which we have been advised during the past month:

Page 52. OXFORD.—A. Tran appointed E. & M.
" 74. WATFORD.—T. C. Battersby, D., G.M., and C.E.
" 78. WISBECH.—J. Green appointed M.D.

Personal

Mr. J. GREEN, Engineer and Manager of the Wisbech Lighting Company, has been appointed Managing Director of the Undertaking, which he has now served for twenty years.

* * *

The appointment of Mr. FRED R. MITCHELL as Assistant Engineer and General Manager of the County of Lanark Gas Undertaking, has been confirmed by the Lanarkshire County Council. He enters upon his new duties immediately. Mr. Mitchell has been Works Manager at the Cambuslang Station of the Lanark Undertaking for the past six years. A native of Dundee, he received his early training in that city with the Dundee Corporation Gas Department. Transferred to the Tayport Gas Department, he was responsible for many important changes effected there during a period of re-organization. So successfully did he perform this task that in January, 1931, he was appointed Engineer and Manager at Tayport. Three years later he was selected from a big list of candidates to succeed Mr. Alex Simmons at Cambuslang. In his new appointment he will assist in the management and administration of the entire County of Lanark Gas Undertaking, which operates a grid system covering a wide area extending from Uddingston to East Kilbride and from Cambuslang to Carfin.

* * *

The Goodenough Gold Medal for the best Paper read to a Salesmen's Circle during 1939 has been awarded to Mr. W. M. DENMAN, Distribution Superintendent to the King's Lynn Gas Company. His subject was "The Standardization of Selling Prices," the Paper being published in the "GAS SALESMAN" for July last year. Prior to his present appointment, Mr. Denman was employed in a similar capacity at Ventnor, from 1914 to 1924, while for six years before that he was Showroom Clerk with the Hertford Gas Light Company.

Obituary

On August 24, the death occurred in her 70th year at her home, Heath Lodge, Hailfax, of Mrs. ISABELLA ROBERTSON MCLUSKY, wife of Mr. W. B. McLusky, until recently Gas Engineer and Manager at Halifax. Mrs. McLusky would have celebrated her golden wedding in November, 1941.

Mrs. McLusky was the daughter of the late Mr. James McCubbin, who was Gas Engineer at Port Glasgow and Monte Video, Uruguay. One of her brothers, the late Mr. John McCubbin, was Gas Engineer at Chorley, Lancs., and Hong Kong and Kowloon. In addition to her husband, she is survived by one daughter and four sons, the eldest having succeeded his father as Gas Engineer and Manager at Halifax. The funeral took place on Aug. 28, at All Saints', Dudwell, Halifax.

Forthcoming Engagements

Sept.

5.—G.C.P.A.—Income Tax Sub-Committee, 5, Victoria Street, S.W.1, 2.45 p.m.

6.—North British Association.—Date provisionally fixed for Annual Meeting at Edinburgh. Papers by Mr. A. B. Munro (Edinburgh) and Mr. J. M. Dow (Kirkcaldy).

10.—N.G.C.—Central Executive Board Meeting, Gas Industry House, 2.30 p.m.

10.—I.G.E.—Finance Committee, 2 p.m.; Membership Committee, 2.30 p.m.

17.—I.G.E.—Gas Education Executive Committee, 11 a.m.; Gas Education Committee, 2 p.m.

19.—Gas Research Board.—Refractory Materials Joint Committee, 2.30 p.m.

26.—Gas Research Board.—Joint Committee on Complete Gasification under Pressure, 2.30 p.m.

26.—Wales and Mon. Association.—General Meeting at Cardiff, 11 a.m.

27.—Gas Research Board.—Joint Research Committee, 2 p.m.

27.—I.G.E.—Liquor Effluents and Ammonia Committee, 12.15 p.m.

Oct.

1.—Gas Research Board.—Finance Committee, 12 noon; Council, 2.30 p.m.

7.—I.G.E.—Finance Committee, 1.45 p.m.; Membership Committee, 2.15 p.m.; General Purposes Committee, 3 p.m.; Benevolent Fund Committee of Management, 4.30 p.m.

8.—I.G.E.—Council, 10 a.m.

9.—I.G.E.—Board of Examiners, 2 p.m.

15.—I.G.E.—Gas Education Executive Committee, 2 p.m.

A Gift of £100 to the local Spitfire Fund was voted at the half-yearly meeting of the Wisbech Lighting Company.

Work has Commenced on the erection at the Johnstone Gas-Works of benzole recovery plant. The plant is being installed by Messrs. R. & J. Dempster, Ltd., and is expected to be in operation in about six months' time.

In the Windows of their showrooms in Osborne Street, Grimsby, the Great Grimsby Gas Company are showing a pictorial display of the work of the Merchant Navy in bringing food and other goods into the country. The display is coupled with an appeal for economy in the use of goods brought in at such a risk.

Owing to the Large Volume of increased business in the supply of overhead radiant heating panels, "Duoflam" conversion sets for boilers, "Aerozone" heaters, grillers, salamanders, and similar equipment, the associate firms of Radiant Heating, Ltd., and A. Docking & Company have removed to larger premises, and are now installed in works at Barnsbury Park, London, N.1.

Successful Experiments have been carried out in Lincoln with low-power street lighting, and it has now been decided that the system shall be extended to the whole of the city's main thoroughfares at an estimated cost of £400. Most of the 400 lamps to be installed will be gas lamps, and the authorities hope to have the installation completed by the end of this month, though this will depend on delivery of the necessary fittings.

The Head Offices of Associated Gas and Water Undertakings, Ltd., and of the East Surrey Gas Company have been moved from 1, Brighton Road, Redhill, to 2, Chart Lane, Reigate, Surrey (Telephone: Reigate 2468. Telegrams: Sagacity, Reigate). A Branch Office and Showrooms of the East Surrey Company will be maintained at 1, Brighton Road, Redhill, where the Telephone Number, which is also that of the Redhill Gas-Works, remains unchanged (Redhill 3201).

The Progress of the Middlesbrough Corporation Gas Undertaking is referred to in a report by the Borough Treasurer. The report says that the number of consumers has increased during the past year from 38,068 to 38,905. The number of cookers is 37,328 compared with 36,097. Wash-boilers in use total 10,254 against 9,791, and gas fires 12,183 compared with 11,567. The number of water heaters in use has been almost doubled, rising from 126 to 235.

A.R.P. Training Bulletin No. 2 has just been published by the Ministry of Home Security. It is a 16-page booklet, modifying and bringing up to date circulars and handbooks already published by the Ministry, and it is principally intended for the use of instructors in the employ of local authorities and industrial and commercial concerns. Among the twenty-two subjects with which the Bulletin deals are hints on the undressing of persons wearing anti-gas clothing, decontamination of clothing and protective equipment, disposal of unexploded high explosive and incendiary bombs, the storage of sandbags, and a reminder regarding the Lighting (Restrictions) Order, 1940, in relation to black-out periods and lighting-up times. The Bulletin is obtainable from H.M. Stationery Office, York House, Kinsgway, London, W.C.2, or through any bookseller, price 3d. Bulletin No. 1 was published in June (6d. net), and others will follow when sufficient new material is available.

Wales and Monmouthshire Association

It has been decided to hold a General Meeting of the Wales and Monmouthshire Association of Gas Engineers and Managers in the Lecture Theatre of the South Wales Institute of Engineers, Park Place, Cardiff, on Thursday, Sept. 26, at 11 a.m. The President and Council hope that circumstances will be such that members will be able to attend this meeting.

There will not be the usual Paper, as it is proposed to arrange for a full discussion upon wartime problems in the Gas Industry.

Should there be any particular questions which members desire to bring forward, they are invited to advise the Hon. Secretary (Mr. E. M. Edwards, Port Talbot), who will then circulate the questions with others so that members may have an opportunity of considering them before the meeting.

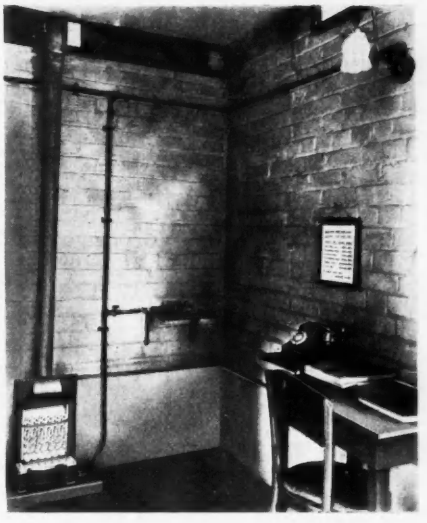
On to the Five Million

Having enrolled its three millionth regular contributor, the Red Cross Penny-a-Week Fund, which was launched on Jan. 29 of this year, has now set itself the task of registering the five millionth by the end of 1940. If this aim is achieved the workers of Britain will be contributing nearly £21,000 a week to Red Cross Funds—rather more than a million pounds a year.

This will be sufficient to meet, at the present rate of expenditure, the whole of the cost of one of the most important departments of Red Cross work—the provision of food parcels, medical and other comforts, books and clothing, for prisoners of war in Germany.

In order to bring about this desirable result the full co-operation of employers is necessary. Details of the scheme may be obtained from the Red Cross Penny-a-Week Fund, 89, Kingsway, London, W.C.2.

Gas for A.R.P. Posts



This A.R.P. post is one of 125 similar posts in an important northern city. In each of them similar equipment has been fitted, consisting of a "Tavistock" gas fire and a boiling burner, supplied by Richmonds Gas Stove Co., Ltd. (Radiation, Ltd.).

Gas Undertaking Results

Colne

The report on the working of the Borough of Colne Gas Department shows that during the year ended March 31 last the quantity of gas consumed in public lamps was 5,648,034 cu.ft., which compares with a figure of 31,251,400 cu.ft. for the preceding twelve months. On the other hand, there was an increase in the amount of gas sold for domestic and industrial purposes of 8.6%, so that the total gas sent out exhibits a decrease of only 10,423,000 cu.ft., at 223,935,000 cu.ft. Over the year the percentage of gas used for central heating purposes rose from 5.86% to 13.55% of the total sent out—that is to say, from 13,724,200 cu.ft. to 30,339,000 cu.ft. Of the 8,713 meters in use at March 31, 5,762 were prepayment. There is a net profit of £1,380 on the year's working, which compares with £2,491 a year ago. Modified street lighting will be in operation during the coming winter.

Perth

When the accounts of the Gas Department for the past financial year were presented to the Perth Town Council, it was pointed out by the Convener of the Gas Committee that, with the sales of gas showing an increase (notwithstanding the considerable loss in consumption due to the curtailment of street lighting) and an enhanced return from all residuals, there was a credit balance of £4,001, which was £3,500 in excess of the estimate. Sales of gas were up by 8,543,981 cu.ft., or 2.08%. The installation of a benzole plant, besides serving an important national need, showed a greater profit than had been estimated.

St. Helens

There has been a decrease during the past financial year in the sales of gas by the County Borough of St. Helens Gas Department of 65,151,063 cu.ft., equivalent to 6.17%. The falling-off in sales directly attributable to the black-out has, however, been no less than 68,000,000 cu.ft. It is stated that the scheme of modified street lighting is progressing favourably. Certain important new industrial loads have been secured. One of these necessitated the laying of a 10-in. main and the installation of a 30,000 cu.ft. per hour meter with duplicate booster plant, and another a 6-in. main and a 6,000 cu.ft. per hour meter. Supplemental agreements and new agreements have been entered into with seven local industrial undertakings, which will have an extremely important effect in the forthcoming year. The total quantity of gas sold in the past year was 990,218,684 cu.ft., as compared with 1,055,369,747 cu.ft. in the preceding twelve months; the amount taken by prepayment consumers being 391,504,153 cu.ft. Of the 28,463 consumers at March 31, 25,795 were supplied through prepayment meters and 2,668 through ordinary meters. Intercommunication with the Prescot Gas Company has been effected. A net profit on the year's working of £5,912 compares with a deficit of £102 for the previous year.

Among the various methods of supplying outlying districts with gas is that described in the following article — namely, drawing from low-pressure mains during off-peak hours and storing under pressure for release back again to the low-pressure system at peak load periods.

Interesting Example of

DISTRICT HIGH-PRESSURE STORAGE

THE twin problems of storage and distribution in growing districts are no inconsiderable proportion of the Gas Engineer's responsibility, and the argument that production is of major importance cannot be substantiated when our market depends upon "delivering the goods." The various departments of a gas undertaking cannot be treated as entirely separate entities, because the first essential for utmost efficiency is the complete co-ordination of the different sections into which the undertaking's administration may be divided.

Having so organized the production of gas that the supply available to the public is of constant calorific value and specific gravity, the Engineer's next concern is to organize the distribution in such a way that the gas so carefully produced at a standard quality shall be available to every consumer at a constant pressure whenever and wherever he requires it. It may be objected at once that this is an unattainable ideal. Nevertheless there should be this state of perfection envisaged towards which we should direct our efforts.

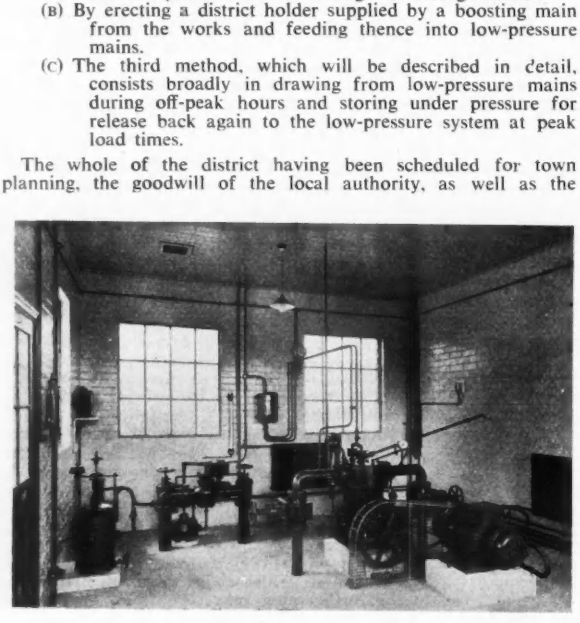
Turning now from the general to the particular, the problem of supplying the outlying districts of a Midland town has been tackled in three different ways :

(A) By boosting gas from the works through special mains to various points on the district and there feeding into the low-pressure mains through district governors.

(B) By erecting a district holder supplied by a boosting main from the works and feeding thence into low-pressure mains.

(C) The third method, which will be described in detail, consists broadly in drawing from low-pressure mains during off-peak hours and storing under pressure for release back again to the low-pressure system at peak load times.

The whole of the district having been scheduled for town planning, the goodwill of the local authority, as well as the



Interior of Compressor House

present and possible future demands in the district and the amenities of the neighbourhood had to be considered in searching for a suitable site. Eventually a suitable site was secured and the necessary "consents" obtained from all owners and occupiers within 300 yds. The nearest existing mains were within ¾ mile in one direction and ¼ mile in another, the latter being 4 in. diameter and the former 6 in. Considering the storage station as a feeder rather than a receiver the connexion to the 6 in. main was laid in 8 in. diameter and to the 4 in. in 6 in. diameter, these being connected to a 10 in. diameter main for the approach to the site.

The lay-out includes a compressor house with provision for duplicating the set, and a nest of receivers with provision for doubling the capacity.

The compressor is a vertical two-crank twin-cylinder single-acting type, capable of compressing 4,000 cu.ft. of gas per hour to 60 lb. per sq.in. pressure. It is driven by a 12½ h.p. totally-enclosed fan-cooled slip-ring induction motor working on a 3-phase 400 volts 50 cycles supply. It is controlled by a totally-enclosed automatic starting panel comprising triple pole stator contractor with no-volt and three overload releases with time lags, rotor starter contactors, test switch, ammeter, and triple pole isolator. There is also a totally enclosed time switch, a low-pressure control switch, together with Bourdon gauge and relay for high-pressure control. A hydraulic regulator is provided for operating the motor switch when the inlet pressure falls below a predetermined point.

The outlet pressure from the receivers is controlled by a modified type of Reynolds district governor to which is fitted a solenoid operating through an auxiliary h.p. regulator for closing the governor when the compressor starts. The compressor is fitted with unloading valves, which release the pressure in the cylinders when the compressor starts. These are operated by an electrically-controlled pilot-valve.

A thermostatically-operated electric immersion heater is inserted in the compressor circulating water inlet pipe to assist starting in extremely cold weather, and a thermostat is also fitted in the water outlet pipe with a mercury contact which cuts out the motor should the water circulation cease or the water temperature rise too high.

There are four mild steel rivetted horizontal receivers each 8 ft. diameter by 30 ft. long, supported in cast-iron cradles upon concrete foundations. Their capacity is 6,000 cu.ft. each at 60 lb. per sq.in. pressure, and they were tested to 160 lb. per sq.in. at makers' works. The connexions are arranged so that any receiver may be isolated or all may be open at once, and each receiver is fitted with a safety valve.

Entirely Automatic Operation

The whole installation is entirely automatic, and the various controls are designed and set so as to cause the least possible disturbance of pressure conditions in the district mains. Thus the time switch is set to start the motor at the beginning of an off-peak period. Should the pressure in the supply main be below the predetermined minimum, however, the hydraulic regulator, which is fitted with a mercury make-and-break switch, will have cut out, thus breaking the motor circuit and preventing the compressor starting.

The maximum pull exerted by the compressor on the inlet main is 7/10ths; so it is necessary to have a margin of 10/10ths. between the cutting-in and cutting-out pressure for which the make-and break switch is set, in order to avoid "hunting." Thus if the cut-out pressure is 30/10ths. the motor circuit will not be completed again until the pressure in the inlet main rises to 40/10ths.

Oscillation of pressure in the nearby district mains is overcome by the insertion of an antifluctuator on the main supplying the compressor. A Bourdon pressure gauge fitted with adjustable maximum and minimum contact points and relays ensures that the motor is switched off when maximum pressure in the receivers is reached and enables a low-pressure point to be determined as an

auxiliary control so that the compressor need not work unless the receivers have been exhausted to that point.

The cost of the station is summarized as follows:

	£
Land	90
Fencing and gates	98
Foundations and building	352
Receivers	1,263
Compressor and governors, &c.	549
Mains and connexions	250
Supervision, &c.	180
	£2,782

The mains and connexions included in the above summary of costs are the 10 in. main to the site and the various connexions on the site. The cost of the 8 in. and 6 in. mains forming the ring system is not included as these serve two other purposes—viz., the linking up of two district extremities, and the supply to premises *en route*.

Maintenance costs over a period of one year are not yet available, but running costs consist of the electric current consumed, oil for lubrication, and a brief daily visit of inspection. Electricity consumed amounts to 3 units per 1,000 cu.ft.

The site was prepared, foundations and building designed and carried out by the gas undertaking's staff, who also laid all the mains. The contract for the compressor and receivers was carried out by the Bryan Donkin Co., Ltd.

Preparation, Drying, and Firing of ENAMELS AND GLAZES

[Contributed]

ATTEMPTS to trace the origin of enamelling and glazing becomes lost in the centuries B.C. when the arts were practised in Egypt, Persia, China, and other parts of the Far East. Examples of early enamelled metal jewelry of the 3rd and 4th centuries B.C. and glazed pottery of the 2nd century B.C. may be found in quite a number of museums. Metal enamelling—and most glazing of pottery—in those early days was of a decorative character, and it is only within the last 150 years that enamelling on iron for purely utilitarian uses has become a commercial proposition.

The early difficulties were largely caused by unsuitable iron, inefficient furnaces for firing, and heavy costs of the materials from which the enamels and glazes are produced. Improved methods of manufacturing borax and soda, investigations into the problems of coloured enamels, and improvements in the means of suspending enamels in solution together formed a basis upon which the great enamelled iron industry of to-day has been built.

Two methods of application are in use, the wet process employing "slips" with the enamel or glaze in suspension, and the dry process wherein the enamel is used in the form of powder, which is dusted on to the material to be enamelled. The latter method is usually employed in the enamelling of cast-iron and for special processes such as "ground-laying" in the ceramic industry. The wet process in which the material to be treated is either dipped into, or sprayed with, the slip is applicable to all classes of earthenware, and to cast-iron, sheet-iron, and sheet-steel products.

Correct Preparation

One of the first essentials of enamelling is correct preparation of the material to be treated. Poor quality iron (or clay or steel) cannot be successfully coated and should be discarded immediately. So, too, should articles which have not been properly cleaned and the surfaces freed from dirt, blisters, pinholes, and projections, which, however small, will almost certainly be discernible in the finished article. This is particularly the case with rust and oxides of iron which often prevent adherence of the enamel, and may cause discoloration. Almost of equal importance is correct design of the article. Sharp edges, acute angles, and thin sections should be avoided wherever possible; the enamel, when molten, will tend to run from such points and, even if they do remain coated, the thickness may be reduced to such an extent as to present a decided weakness which will not become apparent until the article is put to use.

Whereas the glost manager in a ceramic factory will probably be in constant touch with the making department, such a fortunate state of affairs seldom applies in the enamelled metal industry, which makes it even more important that the enameller should have some knowledge of the behaviour of metals and their reactions to various processes.

All traces of grease, oil, and sand must be removed, and marks from moulds and all sharp edges ground off. Oil and grease can be removed by solvents though this is not to be recommended since many solvents leave a fine film on the surface which may prevent adherence of the enamel. Probably the best treatment for cast-iron is blasting with fine grit which leaves a slightly roughened surface ideally suited to the processes which follow. Annealing of the parts and pickling, if required, can be resorted to. If correctly carried out the former relieves strains in the material and the latter provides a good, clean surface for the application of the enamel.

Raw Materials

Since enamels and glazes are closely allied to glass, it follows that the constituents are of a similar nature and may be divided into four main categories—*i.e.*, fluxes, refractories, opacifiers, and colours. The common fluxes are fluorspar, borax, soda ash, lead and zinc compounds, and barium and magnesium carbonate. These re-act with the refractories such as quartz, feldspar, and clay to form the glass base of the enamel. The refractories, in effect, form the body of the enamel, while the fluxes control the melting temperature. Too high a proportion of the latter not only result in a soft enamel but may cause considerable difficulty during the "fritting" process. Since an enamel or glaze composed only from the fluxes and refractories would be somewhat transparent, opacifiers such as oxides of tin and antimony are added to give an opaque appearance to the enamel when fired. The colour of the enamel may be affected by the original constituents, though definite colouring oxides and salts may be introduced in the form of fluxes or refractories. To some extent a liquid glaze or enamel may be likened to a solution in which the particles of colour are held in suspension yet so finely as to appear as a homogeneous body.

Melting of Frits

Following the weighing of the materials plus the necessary allowances for loss on firing—which may vary between 6% and 30%—the constituents are carefully mixed in order to ensure correct reaction between the fluxes and refractories, which also tends to reduce the time required for melting. As the more easily fused materials melt quickly they give some protection to the volatile constituents and prevent their loss in the form of gases. Some of the constituents, such as borax, have a high water content which, on evaporation, protects the other constituents from any deleterious

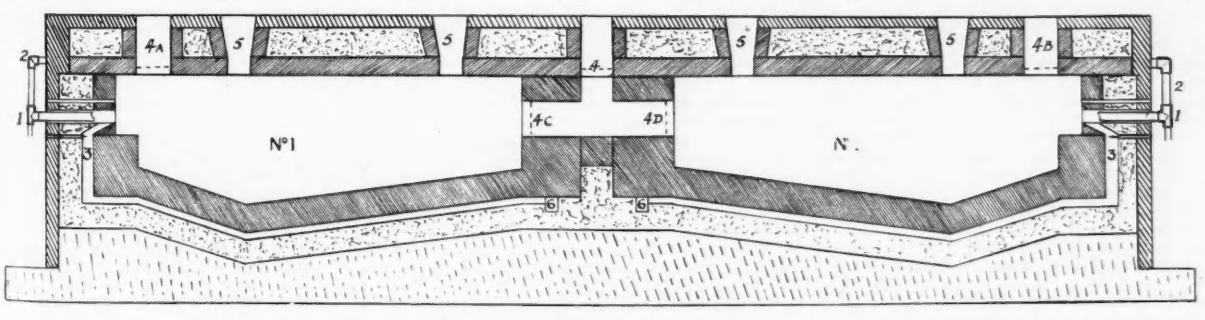


Fig. 1. FRIT MELTING FURNACE.

1 Gas Burners.
2 Air Supply (Pre-heated).
3 Secondary Air Supply (Pre-heated).
4 Main Flue Outlet.
4A, 4B, Auxiliary Flue Outlets.
4C, 4D, Dampers.
5 Charging Holes.
6 Secondary Air Ducts.

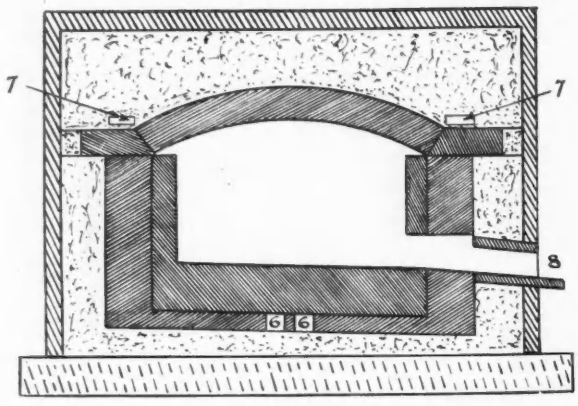


Fig. 2. FRIT MELTING FURNACE.
6 Secondary Air Ducts.
7 Primary Air Ducts.
8 Tapping Hole.

effect from the furnace gases. All traces of iron must be removed from the mixture before placing in the melter, and the latter must be kept clear of dust and dirt if the finished enamel is to be free from specks and blotches.

Time of melting is a most important factor. Too slow melting will permit some of the constituents to be gradually vaporized before correct reaction can be effected, while too rapid melting may result in a frit too hard to suit subsequent processes. The furnaces should be tapped immediately the operator is sure that the mixture is ready for pouring, otherwise loss of some of the volatile constituents may result.

Apart from the small crucible type melter used for laboratory and experimental work, frit melting is carried out either in stationary batch type furnaces or in rotary melters.

The stationary type is usually a substantially built structure with ample insulation on side walls and roof, and, in some cases, the floor also is insulated. The method of working is to fire the furnace continuously—*i.e.*, a new charge being placed in the furnace immediately following the tapping of the previous one, and to carry out this procedure until the inner wall or lining either collapses or is burnt out. The life of the latter is, of course, dependent on the quality of the refractory brickwork, but is largely affected by the reactions between the brickwork and the constituents of the frit.

The crown of the furnace is supported independently of the lining in order that the latter may be repaired or renewed as required. The floor of the furnace slopes in all directions to the tapping hole in order to assist the molten mass to leave the furnace. In many batch furnaces a series of flues are constructed below the floor through which a supply of air for combustion is drawn. To some extent this method has a protective effect on the floor of the furnace and is claimed to extend the life.

Gas Firing

Either single or multiple gas burners, firing from one end of the furnace, may be used, and though various systems of low-pressure gas and pressure-air, high-pressure gas and inspirated air, and pre-mixed gas and air have been used it is probable that low-pressure gas and pre-heated air under pressure provides the simplest and most adaptable method of firing. The flame or flames play over the top of the frit, and as some of the larger furnaces are more than 10 ft. in length, it is obvious that a long lambent flame is likely to give the most uniform temperature throughout the melting zone. The stationary type of furnace affords the advantages of ease of insulation, the use of waste gases to pre-heat the air for combustion, and automatic temperature control, none of which is readily adaptable to the rotary melter.

Fig. 1 shows an improved type of frit melting furnace of the stationary batch type with double melting chambers built back-to-back. In this design each chamber is entirely independent and can be worked as a separate unit. Charging is carried out through the usual openings in the roof of the furnace. In addition to the main flue 4, two additional flues are provided at 4A and 4B, all of which openings are provided with control dampers. When No. 1 chamber only is in use dampers 4A and 4D are closed and the products of combustion pass out of the furnace through the main flue.

By similarly manipulating dampers 4B and 4C a like effect is obtained when it is desired to operate only chamber No. 2. In the event of both chambers being required then damper 4 in the main flue is closed, dampers 4D and 4B opened and the products of combustion passed through chamber No. 2 which is thereby gradually brought near the temperature of firing without the use of additional gas. In a like manner, when both chambers are in use and one is being tapped the dampers are set to pass the heat from the chamber in use to the other one and so reduce heat losses during the period of pouring and re-charging.

Air for combustion on leaving the fan is circulated through a series of tubes in the flues and then carried through the brickwork of the furnace as shown at 7 (Fig. 2) and so to the burners 1. A further supply of preheated air is obtained from the ducts 3 built in the floor of the furnace and discharging immediately below the burner nozzles.

The rotary type of melter is similar in construction to that used for the melting of metals, except that it is usual to have the cylinder fully rotating and lined in such a manner that the frit cannot come into contact with any iron. This type does give a decidedly better mixing of the frit than does the stationary type since the whole mass inside the furnace is constantly in motion. Melting time, too, is appreciably reduced, less floor space is required as no special foundation is required, and labour charges are usually less. Against this must be considered the higher capital cost of the furnace and the fact that fuel consumption per cwt. of frit "off" is much higher than with the stationary type. One further advantage of the rotary furnace, particularly if a number of coloured glazes are made, is that a number of spare lined cylinders may be kept for special colours and mounted in the framework of the furnace as occasion demands.

The capacities of melters range between 2 cwt. and 2 tons or more per charge in the stationary type, and from ¼ cwt. to 10 cwt. in the rotary type. The temperature inside the furnace varies from about 1,000° C. for the softer enamels up to 1,350° C. for some of the higher quality ceramic glazes. Recent tests on the two types of furnace, both melting a similar frit, show a saving of 15% in gas consumption in favour of the stationary type.

Importance of Refractory Lining

In either type of furnace the refractory lining is of extreme importance. Not only must the bricks be of the highest quality, and laid with the finest possible joints, but they must also be free from dirt and incrustations which might be absorbed into the molten frit.

When the frit has attained the correct temperature and the whole of the constituents are thoroughly fused together, the furnace is tapped and the frit discharged into a pit of water. Jets of water are also played on the molten frit as it runs from the furnace to assist in disintegration of the mass, which, on cooling, has the appearance of broken crystalline glass. This must now be ground

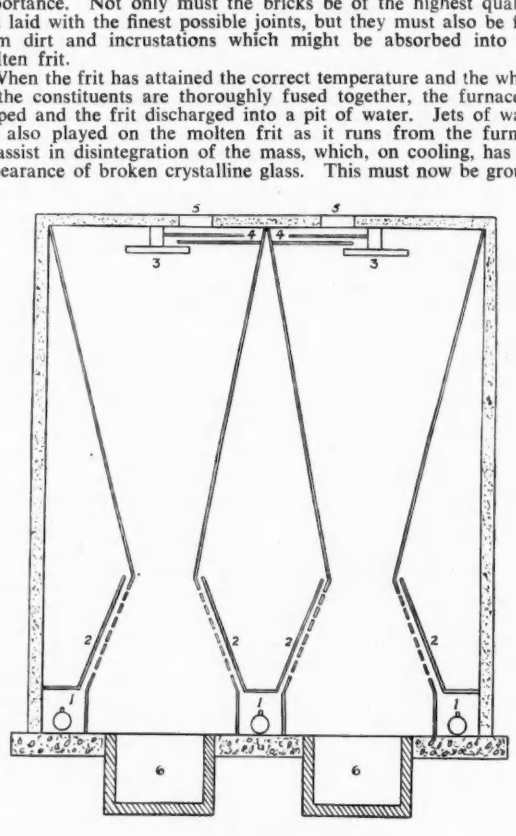


Fig. 3. DRYING CHAMBER.
1 Gas Burners.
2 Baffle Plates.
3 Enamel Sprays.
4 Flue Outlet Baffles.
5 Flue Outlets.
6 Storage Pits.

to the finest powder in specially constructed mills lined with either rubber, porcelain, or very hard silica blocks, and filled to approximately half the cubic capacity with large flint pebbles, which, as they are revolving inside the mill, pick up the frit and grind it into infinitely small particles. When ground with water and other flocculating agents the resultant "slip" may be used in the liquid form either by spraying or dipping the materials to be enamelled. On the other hand, the slip may be simply a mixture of frit, clay, and water from which it is desired to remove the water and use the enamel in the dry state.

Fig. 3 shows a new development in the drying of enamels and glazes after milling. The slip is pumped through extremely fine sprays 3 and disperses in the cabinet. Heat from the gas burners 1 passes in front of the baffles 2 and into the cabinet through the slots shown. These latter are set at an angle to prevent the

enamel (now in the form of extremely fine dust) passing into the burner chambers. The outer surface of the chambers is heated by the hot gases and, being inclined at an acute angle, precipitates any deposits into the storage pits below. Owing to the fine nature of the enamel dust, natural ventilation only plus the effect of the air spraying the slip is used, and baffle-plates are fitted below the outlets in the roof of the cabinet and special dust screens in the outlet ducts.

The dry process of enamel application is generally limited to heavy iron castings and pieces requiring a fairly long period to heat up to the temperature at which the enamel fuses. Sheet iron and steel, and light castings as used for domestic appliances and utensils are usually sprayed, sponged, or dipped and then dried prior to firing.

Faults Due to Insufficient Drying

Many of the faults which develop during usage of enamelled goods can be traced to insufficient drying after application of the liquid slip. Drying should be as prolonged as circumstances permit, at a temperature not less than 120° F. in an atmosphere entirely free from dust. Incomplete drying is the main cause of enamel leaving the surface of the metal during the firing. The thickness of the coating must, to a large extent, control the rate and time of drying, any appreciable amount of moisture left in the enamel will not only tend to cause blistering of the particular piece but the moisture driven-off during firing will probably cause damage to other pieces.

Once a piece of enamelled ware or pottery reaches the firing process it can result only in one of two things—either a good, first-quality article, commanding the highest price, or an inferior piece, in which case the cost of all previous work and processes has been so much waste.

Since many colours, particularly some of the lighter ones used in the ceramic industry, are very susceptible to contamination from sulphur compounds and other products of combustion, muffle or semi-muffle furnaces are preferable where much firing of colours is involved. Correct temperature and furnace atmosphere control, uniformity of heating, firing, and cooling, are essential features for the production of high quality enamelled and glazed goods. In the case of enamelling on metal the temperature varies between 480° C. and 930° C., and the period during which the material remains actually in the firing zone is seldom more than 30 minutes, since the metal can be quickly raised to the desired temperature and quickly cooled off after fusion of the enamel. The main difficulty arises out of the problem of support for the material in order to prevent warping, and this is largely governed by the shape of the articles and the position occupied inside the furnace in relation to the source of heat.

An altogether different set of circumstances apply in the case of glazing of ceramic goods. While the temperature of fusion is much higher, ranging from 980° C. to 1,200° C., the material can only be brought up to temperature at a very slow rate, and cooling must be equally well controlled, with the result that the firing period may vary between eight hours and two days or more. Some idea of the difference between firing enamels on metal and glaze on pottery may be gathered from the fact that 9 ft. to 10 ft. per minute travel is not unusual when firing metals, whereas the rate of travel through a continuous type pottery tunnel is seldom more than 2½ ft. to 3 ft. per hour.

Both intermittent and continuous type furnaces are in common use, but there is little question that the latter gives better results where the load is sufficiently heavy to warrant its adoption. In the intermittent type as used for enamelling the standard practice is to use some form of truck or moveable hearth, on which the materials can be stacked or supported, the whole structure being moved into the furnace and withdrawn on completion of firing. With such a method heat losses are bound to occur during the periods of charging and discharging, and it is necessary that the heat input be sufficiently high to compensate for such losses and also for the loss occasioned by suddenly transferring a mass of cold materials into the hot furnace.

As regards ceramic glazes, it is, of course, not possible to place a load of clay goods inside a furnace that is already somewhere near the fusion temperature of the glaze. Therefore, it is usual to cut off the source of heat immediately on completion of firing, allow the furnace to cool to normal, and re-charge when the fired goods have cooled to such an extent as to permit handling. Here again heat losses during the periods the furnace is shut down are particularly heavy.

The continuous type of furnace affords almost ideal conditions. The materials can be placed, supported, and taken from the furnace with a minimum of inconvenience to the operators. The cycle of firing can be arranged to heat-up, fire, and cool the goods to suit any particular requirement. The furnace can, within limits, be speeded up or slowed down to meet alterations in demand. Absolute uniformity of quality is assured. Control and supervision of firing is reduced to a minimum. Waste heat can be used to greater advantage, and invariable firing costs per article are greatly reduced.

One of the greatest difficulties connected with enamel firing is the prevention of dust infiltration. Even with the continuous tunnel type of furnace trouble may be experienced in this direction due to the continual movement in the tunnel, and the fact that the ingress and exit cannot be closed. Various designs of tunnels, including hairpin and other forms, incorporating methods of air interchange, have been introduced to prevent dust coming into contact with the "tacky" enamel. Some of these improvements, along with air curtains, have gone far to mitigate the trouble, though, even with the best of designs, it is essential to keep the atmosphere around the furnace as free from dust as possible.

Comparative gas consumptions as between various designs of furnace and methods of firing becomes increasingly difficult as the demand for enamelled goods widens. Scarcely two manufacturers fire at exactly the same temperature or for the same time, although often employing the same enamel and making similar articles. Added to this is the fact that in most cases there is a wide variation in the articles passing through the furnace, which at one moment may be firing ground or cover coats on sheet metal, and shortly afterwards be firing cast-iron articles with a correspondingly great increase in the weight of metal to be heated.

ANOMALIES IN THE PROPERTIES AND BEHAVIOUR OF SILICA BRICKS

A Paper given at a recent meeting of the Refractory Materials Section of the British Ceramic Society at Stoke-on-Trent. The first part of the Paper was published in the "JOURNAL" of Aug. 14.

By

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WITH a view to an investigation ot the effect of composition, analyses of several samples were undertaken. *The results are shown in Table VI.

The first analysis is that of an average sample of five of the abnormal bricks (samples 14,849, 14,863, 14,929, 14,941, 14,947). Then follow analyses of four bricks each made from an individual rock. The last two analyses represent two bricks of similar shape but of different appearance drawn from the same kiln. One had a normal colour, the other was pale in colour and resembled the abnormal bricks in composition and in having a rather dead ring. These two bricks were selected for investigation in view of an observation, during an inspection of the undrawn goods in one of the kilns, that in some cases bricks adjacent to one another differed greatly in external appearance. The normal coloured brick had a true specific gravity of 2.33, that of the pale-coloured brick being 2.36.

It will be noted that there is a decided difference in the alumina contents of these two bricks. It is probable, therefore, that though both bricks were free from residual quartz, the conversion of the quartz in the two bricks had occurred at different rates. Since both bricks had been fired at the same time and since they showed similar iron contents, it seems improbable that the colour differences were due to the influence of the iron.

It seems likely that the batches from which bricks 15,065 and 15,066 were made contained different proportions of the individual rocks and especially of rock 15,417. This difference may have been due to accidental errors or to intentional use of an increased amount of one rock due to a temporary shortage of one of the others. It would, however, be responsible for:

(1) An alteration in the alumina content.
(2) A variation in the content of fines, since, as has been already mentioned, the same treatment in the mill produces a much greater proportion of fines in the case of some rocks than with others.
(3) An alteration in the rate of conversion of the quartz.

In connexion with the composition of the bricks made from the individual rocks, it can be stated that the rocks used for the production of bricks 15,062 and 15,063 generally contain much more alumina than would appear to be the case from the analyses. Due, probably, to particular care in the selection of the raw material from which these bricks were made, there has been a decided reduction in the content of superficial clayey matter, and this is reflected in the alumina content of the finished products.

The influence of alumina on silica bricks has been investigated

* All the analyses recorded in this paper were made by Mr. G. T. Cummings.

by Endell and Harr,[9] who found that an increase in this constituent led to an increased porosity and a decreased mechanical strength. They suggested that, for this reason, the alumina content should never be higher than 1.5%. This figure is, however, exceeded in the abnormal bricks and in sample 15,066.

TABLE VI.—Analyses of Bricks of the Make in Question.

Description.	Average Sample of Five Abnormal Bricks.	Bricks made from Individual Rocks.				Normal Coloured Brick.	Pale Brick.
Sample No. or Mark	A	15,060	15,062	15,063	15,064	15,065	15,066
SiO_2	94.18	95.58	96.18	96.30	96.29	95.80	94.58
TiO_2	0.24	0.08	0.14	0.32	0.13	0.12	0.22
Al_2O_3	1.88	1.38	1.03	0.99	0.86	1.30	1.92
Fe_2O_3	0.93	0.69	0.63	0.53	0.66	0.75	0.75
MgO	0.10	0.09	0.03	0.02	0.04	N.D.	N.D.
CaO	2.01	1.28	1.69	1.50	1.45	2.07	1.89
Alkalies as Na_2O ...	0.11	0.16	0.04	0.01	0.03	N.D.	N.D.
Ignition loss	0.16	0.24	0.24	0.30	0.16	N.D.	N.D.
Total	99.61	99.50	99.98	99.97	99.62	100.04	99.36

Results of After-Expansion and Specific Gravity Tests

The results of after-expansion tests at 1,450° C. and at 1,500° C. are given in Table VII which shows, also, the effects produced on the specific gravity and porosity of the samples. It will be evident that all the abnormal bricks gave low after-expansions at these temperatures, even though all had a true specific gravity of either 2.35 or 2.36. Sample 15,060, made exclusively from rock 15,418, had the lowest specific gravity (2.32) of all the bricks, but gave the highest after-expansion (0.45%) at 1,500° C.

Four of the experimental bricks, including three made from individual rocks, showed a slight decrease in specific gravity, accompanied by a marked after-expansion, as a result of the test at 1,500° C. This represents the normal behaviour of silica bricks. On the other hand, there was a slight but definite *increase* in the specific gravity of several of the bricks which had been classed as abnormal. An increase in specific gravity when silica bricks have been re-fired to a high temperature has been noted by previous investigators,[10 11 12] though no explanation has been given of the phenomenon. Dodd[10] records results for three silica bricks M, S, and T, which resemble these abnormal bricks in giving an after-expansion lower than the theoretical or an increase in specific gravity when tested at 1,450° C. He did not refer to the fact that the three bricks had high alumina contents.

TABLE VIII.—Effect of After-Expansion Test (1 Hour) at 1,600° C. on Specific Gravity and Porosity.

Sample No.	Description.	True S.G. before Test.	Percentage After-Expansion.	Values after the Test.		
				True S.G.	Apparent S.G.	Percentage Porosity.
14,996	Abnormal brick.	2.36	0.13	2.36	1.63	31.1
15,060	Bricks from individual rocks.	2.32	0.84	2.31	1.85	20.2
15,062		2.35	0.51	2.35	1.66	29.7
15,063		2.35	0.50	2.35	1.72	26.8
15,064		2.33	0.49	2.35	1.86	20.7
15,065	Low Al.	2.33	Nil	2.35	1.66	29.3
15,066	High Al.	2.36	0.25	2.36	1.64	30.6

In view of the general belief that all silica rocks are converted fairly rapidly into the low-specific gravity forms at 1,500° C. in the presence of accelerators such as lime,[13] it might have been justifiable to assume that the maximum limit of conversion had been reached in the test carried out at this temperature. To test this point, samples of several bricks were heated for one hour at 1,600° C. Table VIII shows the results obtained.

As in the case of the test at 1,500° C., sample 15,060, the brick with the lowest true specific gravity, showed the highest after-expansion. This expansion was not accompanied by any noticeable development of cracks, and the fact that the porosity was but slightly affected suggests that cracks were not formed.

As was observed in the test at 1,500° C., a definite increase also occurred in the specific gravity of some, namely two, of the bricks in the experiment carried out at 1,600° C., but in this case the feature is not confined to the samples with a high-alumina content. In view of the results obtained, a test at 1,600° C. was carried out on four bricks of other makes. Table IX gives the results, together with the results of a standard test previously carried out at 1,450° C. Partial analyses of three of the bricks are given in Table X.

All these bricks contain less than 94.5% of silica and the increase in specific gravity shown by samples 14,756 and 15,271 is probably due to the high lime content, aided, in the case of sample 15,271, by the comparatively high alumina content.

Sample 15,255 did not show an increase in specific gravity, since much quartz was present and was eliminated as a result of the heating. Had this not been so, an increase in specific gravity would probably have occurred. It is evident from the increase in porosity, that cracks must have developed in sample 15,255, though they were not noticeable.

TABLE IX.—Tests on Bricks of Other Makes.

Sample Number.	Original Brick.			After-Expansion		After Test at 1,600° C.		
	True S.G.	Apparent S.G.	Percentage Porosity.	At 1,450° C.	At 1,600° C.	True S.G.	Apparent S.G.	Percentage Porosity.
14,756	2.32	1.69	27.3	Nil	−0.09%	2.34	1.71	26.7
15,249	2.32	1.81	21.9	Nil	−0.14%	2.33	1.83	21.5
15,255	2.36	1.69	28.3	0.34%	2.94%	2.36	1.56	33.9
15,271	2.32	1.74	25.3	Nil	−0.18%	2.34	1.73	26.2

TABLE X.—Partial Analysis of Bricks of Other Makes.

Sample. Number.	SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	MgO.	CaO.
14,756	93.94	0.12	0.97	0.75	N.D.	2.40
15,255	94.02	0.10	1.89	0.84	0.13	2.30
15,271	94.42	0.22	1.39	0.73	N.D.	2.44

The results of all the tests suggest that an increase in specific gravity as a result of heat treatment at 1,600° C. only occurred in bricks containing little or no quartz and having a specific gravity not exceeding 2.35.

Discussion of Results

It has been mentioned that excessive local temperatures were attained in the kiln in which some, at least, of the abnormal bricks were fired. The effect of the severe heat treatment was that bricks with an unusually high specific gravity were obtained. It seems probable that the specific gravity may have fallen to a minimum value and may subsequently have increased while the bricks were still in course of being fired. The effect is comparable with the further increase in specific gravity which took place when certain of the bricks were heated in the laboratory to 1,500° and 1,600° C.

This increase in specific gravity as a result of heat treatment does not appear to be confined to bricks containing an unusually high proportion of alumina, except, perhaps, in the case of the firing at 1,500° C. It would seem that high lime content may have a similar effect.

The actual effect produced by heat treatment on the specific

TABLE VII.—Effect of After-Expansion Tests at 1,450° and 1,500° C. on Specific Gravity and Porosity.

Sample Number.	Samples as Received.			After Firing at 1,450° C. for 2 hours.				After Firing at 1,500° C. for 2 hours.			
	True S.G.	Apparent S.G.	Percentage Porosity.	Percentage After-Expansion.	True S.G.	Apparent S.G.	Percentage Porosity.	Percentage After-Expansion.	True S.G.	Apparent S.G.	Percentage Porosity
Ten Original Routine Samples which gave Abnormal Results.											
14,929	2.36	1.65	30.3	0.10	N.D.	N.D.	N.D.	0.13	2.37	1.65	30.1
14,941	2.35	1.65	29.8	0.08	"	"	"	0.11	2.36	1.65	30.3
14,946	2.35	1.65	30.0	0.07	"	"	"	0.07	2.36	1.62	31.5
14,947	2.36	1.63	31.1	0.03	"	"	"	0.07	2.36	1.62	31.5
14,949	2.35	1.64	30.3	0.03	"	"	"	Nil	2.35	1.63	30.6
14,970	2.36	1.62	31.6	0.16	"	"	"	0.13	2.37	1.61	32.0
14,971	2.36	1.60	32.4	0.12	"	"	"	0.16	2.37	1.60	32.5
14,995	2.35	1.63	30.7	0.11	"	"	"	0.07	2.36	1.64	30.4
14,996	2.36	1.63	30.6	0.08	"	"	"	0.13	2.36	1.62	31.4
14,997	2.36	1.65	30.2	0.10	"	"	"	0.07	2.36	1.62	31.4
Five Experimental Bricks prepared by the Makers.											
15,060	2.32	1.90	18.1	0.09	2.31	1.87	19.4	0.45	2.31	1.85	20.0
15,061	2.34	1.74	25.5	0.13	2.34	1.78	23.9	0.39	2.33	1.78	23.5
15,062	2.35	1.67	28.8	0.13	2.35	1.67	28.9	0.39	2.34	1.67	28.5
15,063	2.35	1.75	25.6	0.10	2.35	1.75	25.6	0.39	2.34	1.73	25.9
15,064	2.33	1.86	20.1	0.03	2.33	1.89	19.2	0.32	2.33	1.83	21.5
Two Bricks of Similar Shape from the same Kiln.											
15,065	2.33	1.66	28.9	Nil	2.33	1.66	28.6	Nil	2.33	1.66	28.7
15,066	2.36	1.64	30.5	0.22	2.36	1.63	31.1	0.29	2.37	1.63	31.1
Experimental Brick of known Grading.											
15,179	2.35	1.63	30.4	N.D.	N.D.	N.D.	N.D.	Nil	2.36	1.63	30.7

gravity of the bricks is the resultant of a decrease due to conversion of residual quartz and of an increase due to conversion of tridymite into cristobalite and to formation of glassy matter. Quartz conversion would be associated with an expansion, and, if it occurred rapidly enough to set up strains followed by the development of cracks, with an increase in porosity. At the same time, disruption of the bond between the coarser grains and the matrix might result, and this would give rise to numerous fine cracks and to a "punky" structure. On the other hand, formation of glassy matter might result in a contraction and, possibly, in a decrease in porosity. As an accessory cause of an increase in specific gravity, the liberation of gas from sealed pores in a glassy matrix, rendered less viscous under the influence of a high temperature, cannot be excluded.

Dale[14] has suggested that, in a silica brick kiln, it might be of advantage to proceed with the firing until the maximum attainable temperature has been reached and then to allow a short soaking period. He concedes that conversion of β quartz into β cristobalite at too rapid a rate is liable to produce a friable brick, but suggests that a healing effect on the structure may be exerted if the temperature is allowed to fall slightly and a further soaking is given.[6] Dale also advances the view that the above-mentioned weakness may be the result of the devitrification of a highly viscous glass.[15] If devitrification does occur as a result of the exposure of the bricks to a high temperature for a long period subsequent to the attainment of a still higher temperature, it would be expected that a decrease in the true specific gravity would occur due to separation of tridymite from the glass. Rapid cooling from the peak temperature would minimize devitrification and the glassy matter would persist. In this connexion it may be mentioned that it has been found possible to bring about the devitrification of lime-alumina-silica eutectic glass in the laboratory by heating it at a temperature just below the melting-point.

Factors in the production of bricks with a dead ring may, therefore, be a faulty firing schedule and failure to secure the optimum grading in the brick batch. When several rocks, differing in hardness, are employed and are ground in the same mill, an excessive production of fines may be avoidable if the individual rocks are charged in an appropriate sequence and the rollers are suitably adjusted. In order that strains due to irregular expansion may be avoided, it is obviously desirable that the matrix be constituted from the rocks which are convertible with difficulty, the grog being provided by the most readily convertible rocks[14] and by the silica batts (fired brick). This desideratum must be taken into account in conjunction with the formulation of the charging schedule and some compromise may be necessary if the best results are to be obtained.

It is the generally accepted view[16] that the degree of quartz conversion and the after-expansion of silica bricks are closely related to their true specific gravity. The present investigation suggests, however, that though bricks with a low true specific gravity can definitely be regarded as having been well fired, no views based on specific gravity alone can be expressed as to whether bricks with a specific gravity in the neighbourhood of 2.36 have received sufficient heat treatment for the conversion of all the quartz. No evidence is available as to the behaviour during use of bricks of the nature of those discussed in this Paper, though it is apparent that their production has been the result of a very high firing temperature. Over-firing of silica bricks is obviously not an economic proposition, quite apart from any possible detrimental effect which may be produced.

Dodd[17] has expressed the view that an expanded variety of cristobalite may be formed at high temperatures. This could account for the high after-expansion which may sometimes occur, without any change in true specific gravity, when silica bricks with a fairly low specific gravity are re-fired. It has recently been shown[18] that, at a pressure of 50 tonnes per square centimetre, cristobalite is converted into a new form of silica with an increased refractive index. The specific gravity of the new form is unknown, but it is possible that intergranular or matricial pressures of such an order may be developed in silica bricks due to expansion of the grains.

Summary

Evidence has been adduced to the effect that:

(1) The true specific gravity of well-burnt silica bricks of certain types may increase if the bricks are re-fired to a high temperature subsequent to manufacture. This increase may take place in the kiln itself if the firing temperature is excessive.

(2) In cases where the increase in specific gravity has occurred during the kiln burning after a minimum value has been attained, subsequent heat treatment at temperatures of 1,450° or 1,500° C. does not again reduce the specific gravity, but tends, rather, to increase it still further.

(3) Bricks of this nature generally show but a small after-expansion when tested at 1,450° or 1,500° C.

(4) In the case of bricks which have a true specific gravity in the neighbourhood of 2.36, no views based solely on specific gravity can be expressed as to whether the kiln treatment has been adequate to secure complete conversion of the quartz.

(5) The occurrence of an increase in true specific gravity would seem to be associated with a high alumina and/or lime content and with a silica content, below 95% and may be ascribed, at least partially, to conversion of tridymite into cristobalite. It takes place chiefly in the case of bricks containing little or no quartz and having specific gravities not exceeding 2.35.

(6) The development of a weak structure is generally due to an excessive rate of conversion of the quartz, leading to differences between the expansions of the matrix and the coarser grains. As a result, strains are developed and cracks are formed. These effects are accentuated if a high proportion of fines is present since the elasticity of the structure is lowered due to consequent diminution in the proportion of impurities in the matrix. Bricks which have a weak structure due to these causes are almost invariably oversize.

(7) In bricks containing a high proportion of fines, the development of a further proportion of glassy matter would necessarily require exposure to a very high temperature, since the matrix would be relatively free from fluxes.

(8) The existence of another form of silica with a true specific gravity rather higher than that of cristobalite seems to be a possibility.

The Authors are indebted to Mr. C. Russell for various suggestions and to Mr. W. Hugill, of the British Refractories Research Association, for observations on the microsections of the bricks and rocks and helpful comments and for the photomicrographs* of the sections.

They wish, in conclusion, to express their thanks to the Directors of the Woodall-Duckham Companies for permission to present this Paper.

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* There were 10 photomicrographs accompanying the Paper.

Trade News

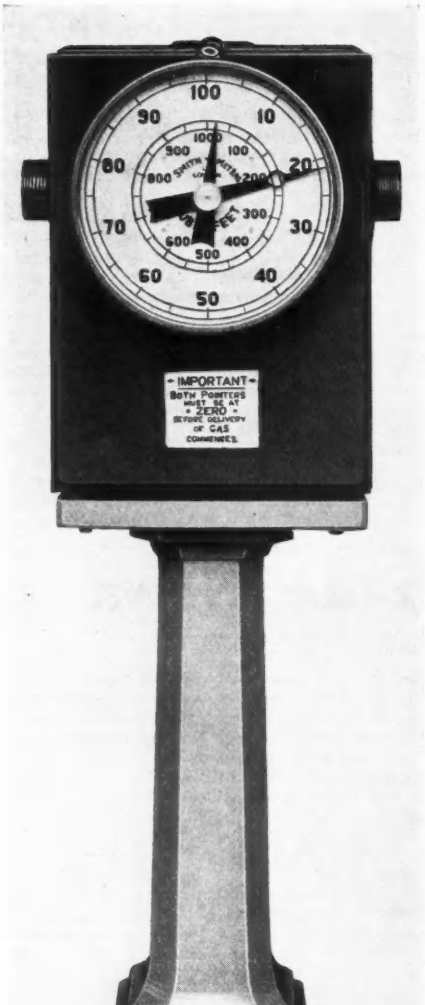
Porcelain Products

For the convenience of users who are finding difficulty in obtaining supplies of special articles the V.G. Manufacturing Company, Ltd., Gorst Road, Park Royal, has issued an interesting booklet presenting in a concise manner the high quality porcelain accessories which they supply to the Gas Industry and the electrical, chemical, and allied industries. Of chief interest are V.G. contact rings for use in the chemical and allied industries where it is essential that vapours and gases be brought into the closest contact with liquids. They are recommended for use in refrigeration, air conditioning, tar extraction and distillation plants, and in laboratory experimental equipment. V.G. pellets, made from a pure china clay, free from iron and other impurities, are supplied as a catalyst carrier in the removal of sulphur from gas and benzole. The pellets have a density of 56½ lb. per cu.ft. and will absorb 33% of their own weight of water and dry out again completely to their original weight. The booklet also describes a variety of porcelain connectors for electrical joints, including the "Scruit," the "Conex," and the "S.S." block connector, a range of V.G. interlocking insulating beads for maintaining effective insulation of the wires or elements on which they are threaded, and "Vee-Gee" sticky thread for miscellaneous uses. Finally, the booklet invites enquiries from gas undertakings for special products for heat-resisting purposes up to a temperature of 1,350° C.

"A Reminder"

A new folder has recently been issued by Robert Dempster & Sons, Ltd., of Elland, to their friends in the Gas Industry. This little folder is appropriate to the times, and its aim is so aptly summed up in the message contained between the two covers devoted to photographic illustrations of the firm's gas-works installations that we think the words are worthy of reproduction. In the light of present-day events, it is observed, the word "propaganda" has unhappily acquired a new and somewhat sinister association. We hesitate, therefore, to apply the term to this modest wartime production. Rather let us call it a reminder—that, in war as in peace, Dempster's of Elland remain at the service of the Gas Industry. In these days you may have little time, and perhaps less inclination, to study Contractors' literature. Accordingly we have made our message brief, seeking virtue in worthiness rather than wordiness.

METERS FOR TRANSPORT
GAS FUELLING



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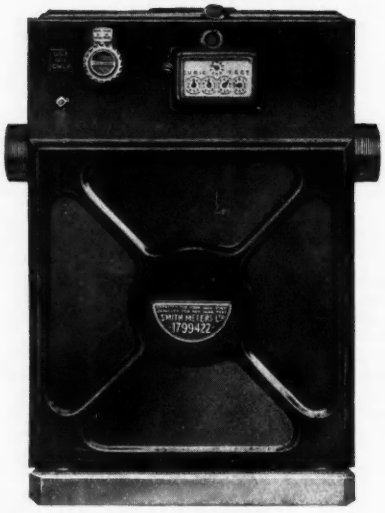

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Gas Products Prices

The London Market

Sept. 2.

Prices of tar products generally in the London market remain unchanged, to-day's values being as under: Pitch remains nominal, creosote is about 4¾d. to 5d. per gallon, refined tar 3¾d. to 4d., the price of pure toluene under the Ministry of Supply Toluene No. 2 Order is 2s. 5d. per gallon, pure benzole 1s. 10d., 95/160 solvent naphtha 1s. 11d. to 2s., and 90/160 pyridine about 17s. 6d., all per gallon naked, refined naphthalene crystals £23 per ton in bags, all *ex* Makers' Works.

The Provinces

The average prices of gas-works products during the week were: Pitch and Crude Tar.* Toluole, naked, North, 1s. 9½d. (Controlled by the Ministry of Supply Order No. 1, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North 9d. to 9½d. Solvent naphtha, naked, North, 1s. 8d. to 1s. 9d. Heavy naphtha, North, 1s. 4½d. to 1s. 5½d. Creosote, *ex* works, in bulk, North liquid and salty, 4½d. to 4¾d.; Scotland, 4¼d. to 4¾d.; low gravity, 4½d. to 4¾d. Fuel Grade, 4d. to 4¼d. Carbolic acid, 60's, 3s. 6d. to 3s. 7½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil, (min. gr. 1,080), 5¼d. to 5½d.; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d.; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

*The impossibility of giving a crude tar price, in the absence of any market price for pitch (which comprises 50-60% of a ton of crude tar), has, we understand, raised difficulties in the case of a number of contracts which are based upon the price normally given in the "JOURNAL" from week to week. Our Market Correspondent is not prepared to give a "nominal" price for pitch, upon which a tar price could be based; there was, we believe, trouble in the Courts over such a price at the end of the last War. Our Correspondent suggests that parties might perhaps agree among themselves upon a price to be paid on account, on the understanding that when there is again a market for pitch we should try to fix upon a composite price to cover the period which has intervened, and also give what we think would be a fair price for tar, based upon that figure, for each month of the period during which no prices for crude tar have been inserted. We shall be grateful if interested parties will write to us giving their views upon such an arrangement, so that if there is any consensus of opinion we can act accordingly.

Scotland

GLASGOW, Aug. 31.

Deliveries against contract for most Tar Products are being well maintained, but little new business is being arranged.

Refined tar.—A small but steady throughput is maintained, and price in the home market is 4¼d. to 4½d. per gallon. Export business is being arranged at about 3½d. per gallon, both f.o.r. naked.

Creosote oil.—This material is moving regularly at about the following levels: Specification oil, 5d. to 5¼d. per gallon; low gravity, 6d. to 6½d. per gallon; neutral oil, 5¾d. to 6d. per gallon; all *ex* Works in bulk.

Cresylic acid.—This market is featureless at the moment, and prices are as under: Pale, 97/99%, 1s. 11d. to 2s. per gallon; Pale, 99/100%, 2s. 2d. to 2s. 4d. per gallon; Dark, 97/99%, 1s. 7d. to 1s. 9d. per gallon; all *ex* Works in buyers' packages.

Crude naphtha.—Available supplies are commanding 6½d. to 7½d. per gallon, *ex* Works in bulk, according to quality.

Solvent naphtha.—90/160 grade is 1s. 8½d. to 1s. 9d. per gallon, and 90/190 heavy naphtha is 1s. 4½d. to 1s. 5½d. per gallon.

Motor benzole is 1s. 8d. to 1s. 8½d. per gallon.

Pyridine.—90/160 grade is 17s. to 18s. per gallon, and 90/140 grade is 19s. to 20s. per gallon.

Dividend Announced

Coatbridge

The Directors of the Coatbridge Gas Company have declared a final dividend on the Company's stock for year ended June 30 last at the rate of 9¼%, making 14¼% for the year, and on the shares at the rate of 12s. 11.4d., making 19s. 11.4d. for year.

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A.R.P.

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GAS STOCKS AND SHARES

Conditions on the Stock Exchange remained much about the same last week. Business was small and selective, while supplies of stock were short in nearly all sections. The support for gilt-edged stocks continued, and further fractional rises occurred during the week—2½% Consols closing ¼ higher at 74. The home rail market was almost lifeless. The industrial section was also quiet, but here and there some sharp upward movements were made as a result of favourable annual reports. Oil shares, though quiet, were by no means weak, but rubber and tea shares remained idle.

There was more business done in the Gas Market last week, and with few exceptions prices closed unchanged. As will be seen in the lists below, Bournemouth maximum stock dropped 8 points to 105 and Southampton 3 to 67½. South Metropolitan, on the other hand, gained a further point to 53½. There were no changes apart from *ex* div. markings on the Provincial Exchanges or in the Supplementary List.

There is still a fairly plentiful supply of ordinary stock available, and at current prices the yields obtainable on the assumed dividends, which in most cases are double the last interim, are substantial, and even if the assumed dividend is not quite maintained in any particular case a purchase may well turn out to be a profitable lock-up. The following are among those now on offer :

Amount offered. £		Assumed Dividend % p.a.	Price.	Gross Yield % £ s. d.
1,000	Barnet Gas and Water ...	7	117	5 19 8
1,000	Bournemouth Gas and Water ...	7	111½	6 14 6
1,780	Bristol	5	93	5 7 6
1,500	British	7½	90	8 6 8
1,700	Croydon 5% Max. ...	5	83	6 0 5
500	East Hull	5	80	6 5 0
1,000	Gas Light units	4½	15s. 3d.	5 18 0
1,680	Mid Southern "C" ...	5	75	6 13 4
500	Oriental	8	111	7 4 2
1,500	South Suburban	4½	68	6 12 4
1,700	United Kingdom Gas Corpn. ...	5	13s. 3d.	7 10 11
500	Wandsworth	5	72	6 18 10

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Pref. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Aug. 30.	Rise or Fall on Week.
1,767,439	Mar. 11	8	7	Alliance & Dublin Ord. ...	105—115	...
374,000	July 1	4	4	Do. 4 p.c. Deb. ...	90—95	...
957,608	May 13	5	5	Asscd. Gas & Water U'd'ts Ord.	12/—14/	..
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	15/6—17/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/—14/—	..
561,370	Aug. 12	7	7	Barnet Ord. 7 p.c.	111—116	..
300,000	Apl. 8	1/4⅝	1/9⅜	Bombay, Ltd.	19/6—21/6	...
690,407	Agu. 19	7	7	Bournemouth 7 p.c. max. ...	100—110	- 8
362,025	June 17	4	4	Do. 4 p.c. Deb. ...	90—95	...
659,955	Aug. 19	6⅜	4⅜	Brighton, &c., 5 p.c. Con. ...	67—77*	...
855,000	Mar. 11	7	8	Brit. Gas Light Ord.	77—87	...
545,000	June 17	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	75—80	...
10,000	Nov. 6, '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	¼—¾	...
626,860	July 15	5⅞	6	Cardiff Con. Ord.	89—94	...
24,500	Apl. 8	7	7	Colombo Ord. 7 p.c. Pref. ...	19/6—21/6*	...
764,169	Mar. 26	/11.48	-/11.48	Colonial Gas Assn. Ltd. Ord. ...	14/6—16/6	..
400,000	,,	1/3.30	1/3.30	Do. 8 p.c. Pref. ...	20/—22/—	...
1,748,935	July 22	2	3	Commercial Ord.	37—42	..
620,000	June 10	3	3	Do. 3 p.c. Deb.	58—63	...
286,344	Aug. 19	5	5	Do. 5 p.c. Deb.	88—93*	..
807,560	Aug. 12	7	6	Croydon sliding scale	87—92	...
644,590	,,	5	5	Do. max. div.	80—85	...
620,385	July 1	5	5	Do. 5 p.c. Perp. Deb. ...	90—95	...
179,500	Aug. 19	5¼	5	East Surrey 'B,' 5 p.c.	75—80*	...
176,461	June 17	5	5	Do. 5 p.c. Deb. (Irred.)...	90—95	...
250,000	July 8	4	6	Gas Consolidation Ord. 'B' ...	13/—15/—	...
250,000	May 13	4	4	Do. 4 p.c. Red. Cum. Pref.	15-/—17/—	...
19,152410	July 29	3½	4½	Gas Light & Coke Ord. ...	14/3—15/3a	...
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	54—59	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	72—77	- 1
2,993,000	July 8	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	78—83	...
8,602,497	June 3	3	3	Do. 3 p.c. Con. Deb. ...	65—70	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	99—104	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	98—103	...
700,000	Mar. 11	3¼	3¼	Do. 3¼ Red. Deb.	80—85	...
5,600,000	May 13	4	8	Imperial Continental Cap. ...	37—42	...
43,820	July 29	3½	3½	Do. 3½ p.c. Red. Deb. ...	63—68	...
231,978	Aug. 19	5	5	M.S. Utility 'C' Cons.	68—73	...
918,657	,,	4	4	4 p.c. Cons. Pref.	72—77	...
675,000	May 6	†4	†4	Montevideo, Ltd.	52—57	...
300,000	Apl. 29	9	7	Oriental, Ltd.	100—110	...
368,537	June 3	7	8	Plymouth & Stonehouse 5 p.c.	90—100	...
621,667	Aug. 19	8⅛	7½	Portsmouth & Gosport Cons.	97—102*	...
648,999	Apl. 29	1/1½	1/1	Severn Val. Gas Cor. Ld. Ord.	14/—16 -	...
597,972	Mar. 11	-/10⅞	-/10⅝	Do. 4½ p.c. Cum. Pref. ...	16/—18/-	...
2,528,714	April 29	1/2⅜	1/-	South East'n Gas Cn. Ld. Ord.	11/—13/-	...
1,000,000	Mar. 4	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	...
1,068,869	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	13/—15/-	...
6,709,895	Aug. 5	4	4	South Met. Ord.	51—56	+1
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	98—108	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	70—75	...
1,895,445	July 1	3	3	Do. 3 p.c. Perp. Deb. ...	60—65	...
1,100,000	July 15	5	5	Do. 5 p.c. Red. Deb. ...	95—100	...
1,543,795	July 22	3	4	South Suburban Ord. 5 p.c. ...	60—70	...
512,825	July 8	5	5	Do. 5 p.c. Perp. Pref. ...	88—93	...
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	71—76	...
250,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	80—85	...
888,587	June 10	5	5	Do. 5 p.c. Perp. Deb. ...	90—95	- 5
750,541	Aug. 19	5½	5	Southampton Ord.	65—70	- 3
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	90—95	...
1,176,495	Aug. 5	5	5	Tottenham & District Ord. ...	68—78	...
338,555	,,	5	5	Do. 5 p.c. Pref.	88—93	...
453,380	June 10	4	4	Do. 4 p.c. Perp. Deb. ...	78—83	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	12/—14/-	..
1,085,952	May 13	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	14/—16/-	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	14/—16/-	...
745,263	June 17	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	12/6—14/6	...
1,200,000	Mar. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	83—88	...
380,606	Aug. 5	7	6¾	Uxbridge, &c., 5 p.c.	93—98	...
1,371,138	July 8	3½	4	Wandsworth Consolidated ...	67—72	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	67—72	...
1,343,964	June 17	5	5	Do. 5 p.c. Deb.	90—95	...
383,745	,,	4	4	Do. 4 p.c. Deb.	80—85	...
558,342	July 15	6	5	Watford & St. Albans Ord. ...	88—93	...
300,000	June 10	3½	3½	Do. 3½ p.c. Red. Deb. ...	85—90	...

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Pref. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Aug. 30.	Rise or Fall on Week.
351,685	June 17	5	5	Brighton, &c., 5 p.c. Perp. Deb.	90—95	...
28,700	,, 17	5½	5½	Do. 5½ p.c. Red. Deb. 1942 ...	96—101	..
415,250	,, 17	4	4	Bristol Gas Co., 4 p.c. New Deb.	85—90	...
140,205	July 29	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	100—110	...
295,932	Aug. 19	5	5	Cheltenham, 5 p.c. Cons. Ord....	88—93	...
42,500	July 1	4	4	Do. 4 p.c. Perp. Deb....	82—87	...
150,000	Aug. 12	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	70—75	...
130,000	July 1	4	4	Do. 4 p.c. Deb. ...	75—80	...
146,700	Aug. 19	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	95—110	...
53,220	,, 19	6	6	Do. 6 p.c. Cum. Pref. ...	100—110	...
117,425	Feb. 5	8	8	East Wight, 5 p.c. Cons. Ord. ...	100—110	...
...	Aug. 19	6	4	Eastbourne, 'B' 3½ p.c.... ..	65—75	...
239,135	July 8	5	5	Gas Consolidation 'A' Ord. (£1)	13/6—15/6	...
156,600	Aug. 19	5	5	Hampton C't, 5 p.c. Cons. Ord.	68—73	...
18,000	June 10	7	7	Malta & Med'n., 7 p.c. 1st Pref.	60—65	...
10,845	,, 10	7½	7½	Do. 7½ p.c. 2nd Pref.	60—65	...
50,000	Aug. 19	£5 19 6	£5 4 6	Mid. South. Util., 'A' Cons. 5 p.c.	63—73	...
65,000	Aug. 12	5	5	North Middlesex, 5 p.c. Pref. ...	85—90	...
70,000	Mar. 11	5	5	Plymouth & Stone., 5 p.c. Deb.	90—95	...
76,501	July 1	4	4	Reading, 4 p.c. Perp. Deb. ...	75—80	...
74,777	April 1	4	4	Romford, 4 p.c. Debs. (Reg.) ...	85—90	...
21,000	June 10	5	5	Slough, 5 p.c. Perp. Deb. ...	90—95	...
211,740	,, 17	5	5	Southampton, 5 p.c. Red. Deb.	96—101	...
363,575	July 1	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	95—100	...
202,019	Mch. 18	7½	6½	Tunbridge Wells, 4 p.c. Scale ...	70—80	...
135,257	June 10	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	90—95	...

PROVINCIAL EXCHANGES

347,756	July 26	6	5	Bath Cons.	98—103	...
122,577	Feb. 19	7	7	Blyth 5 p.c. Ord.	109—111	...
1,667,250	July 15	5	5	Bristol, 5 p.c. max.	90—92	...
120,420	June 17	4	4	Do. 1st 4 p.c. Deb.	94—96	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	92—95	...
328,790	,,	5	5	Do. 5 p.c. Deb.	108—111	...
157,150	Aug. 5	6½	5	Chester 5 p.c. Ord.	98—101	..
92,500	June 17	4	4	Do. 4 p.c. Pref.	80—85	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	80—85	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	94—98	...
542,270	Feb. 12	6	9	Derby Cons.	103—108	...
55,000	June 10	4	4	Do. 4 p.c. Deb.	96—102	...
10,000	Aug. 19	10	10	Great Grimsby 'A' Ord. ...	170—130	...
6,500	,,	10	10	Do. 'B' Ord.	170—180	...
79,000	,,	10	10	Do. 'C' Ord.	160—170	...
732,000	Feb. 19	4	4	Hartlepool G. & W. Cn. & New	63—68	...
2,167,410	Aug. 19	6	6	Liverpool 5 p.c. Ord.	96—98	...
245,500	June 17	5	5	Do. 5 p.c. Red. Pref. ...	97½—100½	...
306,083	July 15	4	4	Do. 4 p.c. Deb.	99—101	...
20,000	June 24	5	5	Long Eaton 5 p.c. Pref. ...	9—11	...
80,000	June 24	5	5	Do. 5 p.c. Deb.	100—105	...
2,430,267	July 29	5⅞	5	Newcastle and Gateshead Con.	15 6—16 6a	...
682,856	,,	4	4	Do. 4 p.c. Pref.	73—75	...
776,706	Dec. 27	3½	3½	Do. 3½ p.c. Deb.	80—85	...
277,285	April 24	5	5	Do. 5 p.c. Deb. '43 ...	97—102	...
274,000	July 26	5	5	Newport (Mon.) Ord.	89—93	...
13,200	Mch. 26	7	8⅔	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	5	6	Do. 7 p.c. 'B'	9½—10½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½	...
106,280	Aug. 5	8	10	Preston 'A' 10 p.c.	157—167	...
188,219	,,	7	7	Do. 'B' 7 p.c.	113—123	...
1,806,339	Aug. 26	6½	6½	Sheffield Cons.	117½—123½*	- 1¾
95,000	July 8	4	4	Do. 4 p.c. Deb.	97— 99	...
332,351	Feb. 5	6	6	Sunderland 6 p.c. max. ...	107—112	...
140,778	Aug. 12	5	5	Weston-super-Mare Cons. ...	87—90	...
64,338	June 24	4	4	Do. 4 p.c. Deb.	90—95	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	140—150	...

a.—The quotation is per £1 of Stock. * Ex. div. † Price free of income-tax.

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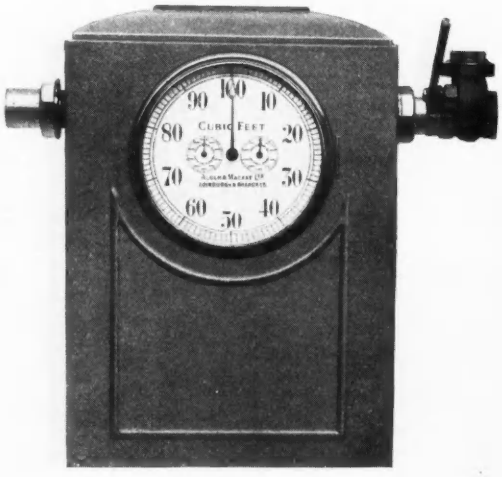

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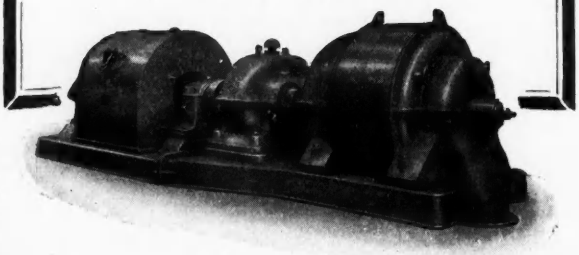

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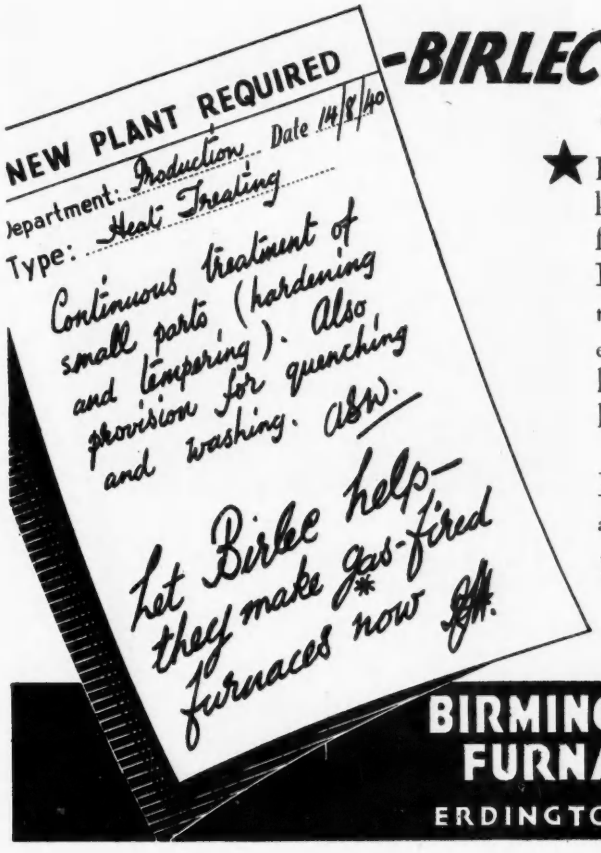
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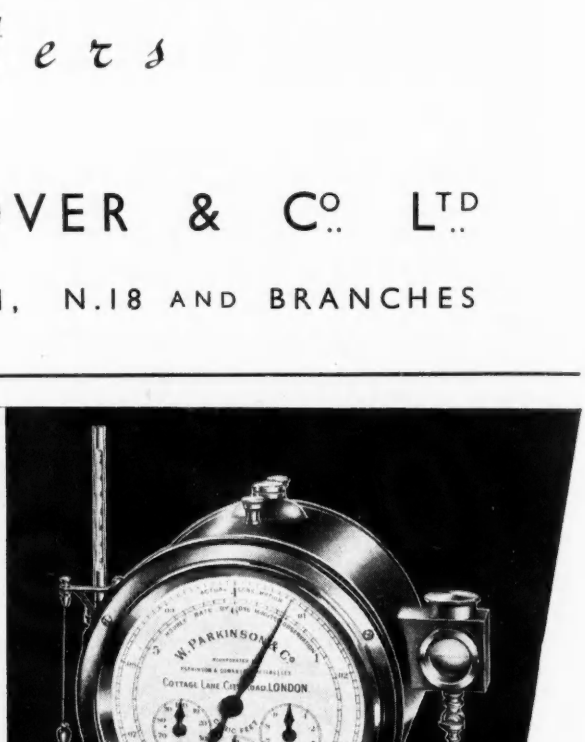

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